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The research of qualitative characteristics of construction materials based on concrete waste

Yulia M. Galitskova[a]*, Elizaveta V. Limarjeva[a]

[a]*Samara State University of Architecture and Civil Engineering (SSUACE), Molodogvardeyskaya St 194, Samara 443001, Russia*

Abstract

Various construction waste is generated in large quantities and can be used in different ways. The authors examined several construction sites, defined the range of construction waste and their proportion in overall total. For this research concrete waste in construction sites have been investigated. The paper presents a methodology of carrying out experiments on determining physical characteristics of concrete waste and items produced from concrete waste and the results of the tests measuring their resistibility and water absorption. The obtained data shows conditions and criteria of waste sorting and justifies the most effective way of re-using concrete waste.

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Keywords: Construction waste; Waste dum; Recycling; Research; Waste characteristics.

1. Introduction

A lot of industrial and construction waste is generated at the production of building materials, construction, repair and demolition of structures. Most waste is associated with the replacement of old buildings and structures being under operation more than thirty years. As a rule, major amount of waste generated at dismounting is utilized at the waste dump. This leads to the loss of a valuable raw material for reuse and to the loss of the urban territory and the areas that are close to settlements [1-4].

* Corresponding author. Tel.: +7-846-242-21-71 .
E-mail address: galickova@yandex.ru

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As quality characteristics of such waste are various it is advisable to conduct preliminary sorting of the generated materials in order to develop the effective way of re-using [5-7]. The analysis of industrial and construction waste show that concrete waste constitutes the largest amount of waste, that is up to 80% of overall total. However, the waste generated at production of building materials and the waste generated at construction, repair and demolition of buildings and structures have different strength and other characteristics which depend on the reliability of buildings and structures. The property characteristics of waste are especially important for its use in hydrotechnical construction [8-20].

The purpose of the conducted research is to determine the most important characteristics of concrete waste for its re-using. The target of the research is the following:

- To determine the amount of silt content in crushed concrete;
- To conduct laboratory research on determining strength and water absorption characteristics of concrete waste;
- To analyze the elements of hydrotechnical structures and to work out application instructions for re-using materials.

2. Research

To determine its characteristics the waste was sorted out under the following conditions:

- Source material represents concrete and reinforced concrete waste subjected to preliminary separation, crushing and fraction sorting;
- Generated crushed concrete of 5-7 mm in diameter was chosen for the research;
- Wittingly, concrete waste had no chemical and radioactive pollutants.

The research was carried out in accordance with State Standard 8735-88*.The first stage of the research was made to determine the amount of dust particles (0.14-0.05mm) and silt particles (<0.05mm) because a great amount of such particles weakens the strength of concrete.

The experiments were made for two fractions: 1) 5-40mm and 2) 40-70mm. According to State Standard after screening the crushed concrete was dried to complete desiccation. As that shown in Figure 1, then water was added and the compound was stirred for two hours, after that the water was drained. In this way every weighed portion was washed at least three times until the water was clear. After soaking the weighed portion was dried to complete desiccation.

After making the experiments the following results were obtained, see Figure 2. Crushed concrete of 5-20mm in size contain on average 0.8% of dust and silt particles while in crushed stone of 40-70mm the percentage of such particles increases up to 1.1% that corresponds to grade 600. When building materials are reused for production the amount of dust and silt particles increases. It has negative impact on the homogeneity of materials and the adhesion of particles when an item is molded. However limit values for re-using concrete waste should not be more than 3% by mass.

The obtained results of the research show that to provide the required workability of cement-sand mass more water is needed for using crushed concrete of fraction 40-70mm than for crushed concrete of fraction 5-20mm.

The next stage of the research was aimed at determining the crushability factor of crushed concrete. For this purpose and in accordance with State Standard the weighed portions of crushed concrete were soaked with water for two hours, then the water was drained and the crushed concrete was put under pressure. The pressure was increased gradually up to 200 kN. After that the crushed concrete was screened again, Figure 3.

This set of experiments allows to conclude that the crushability factor of crushed concrete of fraction 5-20 mm is 18% while crushability factor of crushed concrete of fraction of 40-70mm reaches 29% that is 1.6 times more. Thus crushed concrete for fraction 5-20mm belongs to grade 600 whereas crushed concrete for fraction 40-70mm belongs to grade 400.

Crushability factor is one of the basic values. It has the impact on strength characteristics of crushed concrete, i.e. the ability to sustain different kinds of loads. When crushed concrete is used for concrete production it is possible to determine the grade of concrete being produced.

Figure1. Experiment stages: left – source material, right – soaked weighed portion of crushed concrete.

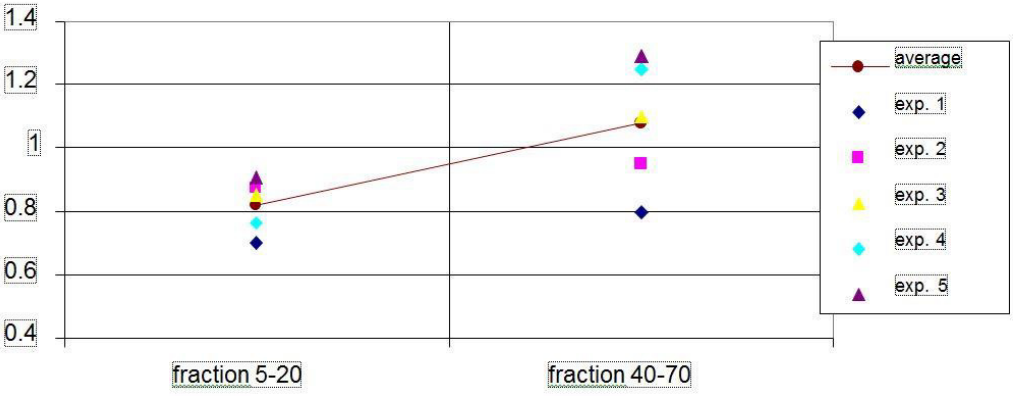

Figure 2. Dust and silt content in mass, %.

Table 1. Results of determining the crushability factor.

Fraction, mm	Crushability factor, %				
	1	2	3	4	5
5-20	18.07	18.12	17.87	18.44	17.64
40-70	28.45	27.94	28.73	29.06	28.63

The following experiments were performed in order to determine water absorption values. For this purpose the weighed portions of crushed concrete of the tested fractures were soaked with water during 48 hours. After that the water was drained and the crushed concrete was weighed again. The results allow to conclude that water absorption of crushed concrete does not depend on the size of fractions and does not increase 5% by mass, as seen in Table 2. Although water absorption of crushed concrete is not standardized, its value has a significant impact on the degree of weathering and frost-resistance.

Table 2. Results of determining water absorption properties of crushed concrete.

Fraction, mm	Water absorption, %				
	1	2	3	4	5
5-20	4.5	4.75	4.86	5.0	4.68
40-70	4.44	4.69	4.57	4.89	4.99

3. Conclusion

Crushed concrete is a valuable raw material that can be used in different construction fields [21-27]. The results of the research described above show the following:

- The bigger the size of crushed concrete the greater the amount of dust and silt particles, thus, the bigger the fraction of crushed concrete the more water is needed;
- Strength properties of crushed concrete of small fraction are better and thus when it has the same other components it makes it possible to obtain concrete of better strength.

Comparative analysis of crushed concrete and natural crushed stone quarried in the Volga area revealed that they have no significant differences in the researched properties.

There are many environmental protection facilities in Samara region with concrete and reinforced concrete being the basic building material. Thousands of m^3 of crushed stone are needed for their reconstruction and repair [28-30]. The researchers offer to use the investigated crushed concrete as the aggregate for concrete. It may reduce the extraction of natural resources and decrease the negative impact of quarry development on the environment. It will also allow to cut the territories of transformed landscapes and to decrease the amount of concrete wastes utilized at waste dumps.

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